SCIENTIFIC NOTE

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Feeding of the estuarine catfish *Cathorops arenatus* (Valenciennes, 1840) in Maiandeua Island, Pará, Brazil

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ABSTRACT

Cathorops arenatus (Siluriformes: Ariidae) inhabits shallow waters and is abundant in the North coast of Brazil. Despite its local use and susceptibility to overexploitation and pollution, basic biological information is lacking to shape conservation actions. Thus, information on the feeding of *C. arenatus* in the North coast of Brazil are provided herein. Specimens were sampled in one expedition during the rainy season and in another in the dry season, using horizontal trawling along a 10-m line. Food contents of 68 specimens were analyzed. They exhibited 13 food items and fed mainly on Haparcticoida copepods and plant fragments. A high number of specimens exhibited sediment in their digestive tract. No differences in the diet composition between hydrological seasons were observed. *C. arenatus* exhibit a benthivorous feeding habit in the Amazonian estuary, which agrees with other species of the genus, and no temporal variation in its diet was found, which may be related to the community dynamics of its main prey.

Keywords: Amazon estuary; Ariidae; trophic ecology.

Dieta do bagre estuarino *Cathorops arenatus* (Valenciennes, 1840) na Ilha de Maiandeua, Pará, Brasil

RESUMO

Cathorops arenatus (Siluriformes: Ariidae) habita águas rasas e é abundante na costa Norte do Brasil. Apesar da sua abundância, uso local e suscetibilidade à superexploração e poluição, informações biológicas básicas para nortear ações de conservação são escassas. Portanto, informações sobre a dieta de *C. arenatus* na região costeira Norte do Brasil são aqui apresentadas. Indivíduos foram amostrados em uma expedição na estiagem e em outra na estação chuvosa, utilizando arrastos horizontais na praia ao longo de 10m. O conteúdo alimentar de 68 espécimes foi analisado, que apresentaram 13 itens alimentares e se alimentaram predominantemente de copépodos Haparcticoida e fragmentos de plantas superiores. Um alto número de espécimes apresentou sedimento em seus tratos digestivos. Não foram observadas diferenças na composição da dieta entre estações hidrológicas. *C. arenatus* exibiu hábitos alimentares bentívoros no estuário Amazônico, o que está de acordo com outras espécies do gênero, e variações temporais em sua dieta não foram encontradas, o que pode estar relacionado à dinâmica de comunidade de suas presas principais.

Palavras-chave: Ariidae, ecologia trófica, estuário amazônico.

Introduction

Cathorops arenatus (Valenciennes, 1840) (Siluriformes: Ariidae) is distributed in the Atlantic Ocean, from Venezuela to North Brazil, and it inhabits shallow waters (MARCENIUK, 2007). *C. arenatus* has a distribution overlap with *Cathorops agassizii* (Eigenmann & Eigenmann, 1888) in the Pará state estuary, but differs from the latter by differences in the size of the eye and barbels, and cranium width (MARCENIUK, 2007). In addition, *C. arenatus* occupies brackish waters, while *C. agassizii* is associated with freshwater (MARCENIUK; MENEZES, 2007). Before the revalidation by Marceniuk (2007), *C. arenatus* was assigned to the species complex *Cathorops spixii* and the use of morphological attributes with sexual and ontogenetic variability hampered correct taxonomic classification. These difficulties in species identification led to a lack of biological information despite its clear high abundance in the Amazonian estuary based on specimens available in zoological collections (MARCENIUK et al., 2017).

Most of the biological knowledge of the genus *Cathorops* is based on *C. spixii* (Agassiz, 1829), which is abundant in shallow coastal waters of South American Atlantic coastline (BARLETTA et al., 2008; DANTAS et al., 2010). *C. spixii* spend its entire life cycle within estuaries and may have an important ecological role because of its abundance and omnivorous diet, composed by prey from low trophic levels (GURGEL et al., 2004; DENADAI et al., 2013; MUTO et al., 2014). In addition, it is important in fisheries for local subsistence in the North coast of Brazil (ESPÍRITO-SANTO; ISAAC, 2012). *Cathorops arenatus* is abundant in the Amazon estuary and may play an important ecological and commercial role as its congener. These species are susceptible to overexploitation caused by shrimp fisheries (DENADAI et al., 2013) and pollution (AZEVEDO et al., 2009; POSSATTO et al., 2011; AZEVEDO et al., 2013), and basic biological information is essential to shape management and conservation actions. Thus, information on the feeding of *Cathorops arenatus* in Maiandeua Island, in the North coast of Brazil, is provided.

Material and methods

Maiandeua Island (Figure 1; 0º 35' 03'' to 00º 38' 29''S, 47º 31' 54'' to 47º 34' 57''W) is a protected area in the Amazon Coastal Zone (ACZ), which is composed by many peninsulas, islands, bays, inlets and estuaries, and it encompasses 35% of the Brazilian coastline (SOUZA FILHO; EL-ROBRINI, 2000; PINHEIRO; FRÉDOU, 2004). ACZ exhibits semidiurnal macrotides and marked variation in rainfall during the year, which

affects the discharge of freshwater into the estuaries and, therefore, salinity levels (BARTHEM; FABRÉ, 2004). Maiandeua Island exhibits a vegetation typical of local *restinga*s (SILVA et al., 2010) and mangroves, with salinity ranging from 15 to 40 (LOBATO et al., 2018).

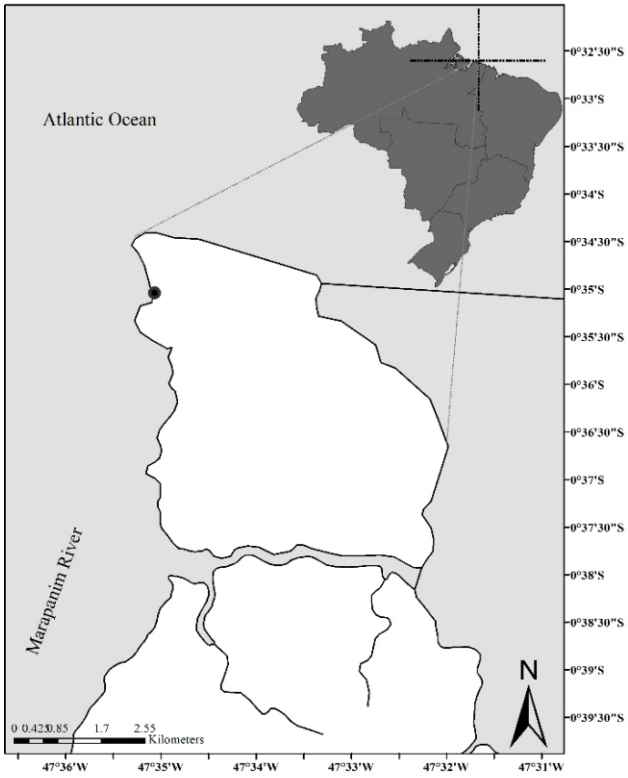

Figure 1. Study site located in Maiandeua Island, Pará, Brazil.

Two sampling expeditions were performed in syzygy tides: one in June 2008, during the rainy season; and another in September 2008, during the dry season. Horizontal beach trawling was carried out along a 10-m line using a net 10-m long and 2-m depth (0.5 cm between opposite knots) until the capture of at least 30 individuals of the focal species. Samplings were carried out always in the day during the high tide. Specimens were fixed in 10% formalin and further preserved in 70% alcohol. In the laboratory, individuals' standard length (SL; mm) and total weight (TW; g) were measured and then the gastrointestinal tracts were extracted. Gastrointestinal contents were analyzed under a stereomicroscope and food items were identified to the lowest taxonomic level possible depending on digestion level and/or fragmentation based on specialized literature (HIGGINS; THIEL, 1988; RUPERT et al., 2004) and classified in three categories.

The feeding of *C. arenatus* were described using the Frequency of Occurrence (FO; HYSLOP, 1980) and the Alimentary Preference Degree (APD; BRAGA, 1999). FO is calculated by the ratio of dietary contents in which the item *i* is present and total number of analyzed dietary contents. APD measures the dominance of food items in dietary contents and is estimated by the dominance of item *i* compared to other items in the dietary contents. APD ranges from 0 (occasional items) to 4 (absolute dominance). Due to the marked seasonality in rainfall, we also performed an Analysis of Similarity (ANOSIM) to evaluate differences in diet composition between the two sampling expeditions based on a Bray-Curtis similarity matrix calculated with APD data for each specimen. ANOSIM was performed in the R environment (v. 2.4). Supporting information including primary data and an additional figure are provided in the Figshare digital repository: 10.6084/m9.figshare.9249116.

Results and discussion

We analyzed 68 specimens, 33 sampled in June (rainy season) and 35 in September (dry season). SL ranged from 54.9 to 99.4 mm (68.0 ± 10.3), and TW ranged from 2.0 to 17.1 g (5.7 ± 3.3). Only two specimens did not exhibit gastrointestinal contents and were excluded from further analyses. Sediment was observed in 97.1% of analyzed food contents and Poecilostomatoida copepods, commonly associated with parasitic habits, were found in three specimens. *C. arenatus* exhibited 13 food items classified in two major categories by its source: vegetal and animal items (Table 1). The species fed on Harpacticoida copepods and plant fragments in both seasons (FO > 50%; APD > 1.0). We observed no differences in the diet composition between the two seasons (ANOSIM; R = 0.03; p = 0.09).

Table 1. Frequency of Occurrence (FO) and Alimentary Preference Degree (APD) of food items consumed by *Cathorops arenatus* in June 2008 (rainy season) and September 2008 (dry season) in the Maiandeua Island, Pará, Brazil. Higher values are shown in bold.

Source/Food item	Rainy season		Dry season		Total	
	FO	APD	FO	APD	FO	APD
Algae						
Algae	0.31	0.80	0.30	0.73	0.31	0.76
Vegetal						
Plant fragments	0.69	1.40	1.00	2.24	0.84	1.81
Animal						
Bivalvia	0.11	0.17	0.12	0.12	0.12	0.15
Copepoda: Harpacticoida	0.51	1.54	0.52	1.36	0.51	1.46
Crustacea: Malacostraca	0.00	0.00	0.03	0.09	0.01	0.04
Crustacea: Anomura	0.03	0.09	0.18	0.30	0.10	0.19
Crustacea: Anomuran eggs	0.03	0.06	0.06	0.09	0.04	0.07
Exoskeleton fragments	0.09	0.26	0.27	0.36	0.18	0.31
Insecta: Diptera	0.06	0.06	0.00	0.00	0.03	0.03
Insecta: Hymenoptera	0.00	0.00	0.03	0.03	0.01	0.01
Insecta: Non-identified	0.06	0.09	0.30	0.45	0.18	0.26
Fish fragments	0.00	0.00	0.03	0.09	0.01	0.04
Fish scales	0.20	0.20	0.33	0.33	0.26	0.26

Cathorops arenatus exhibited a benthivorous diet based on plant fragments and harpacticoids. Plant fragments are common in the sand in Maiandeua Island for the constant and strong macrotidal wave action, while harpacticoids are benthic copepods that may inhabit many substrates. The genus *Cathorops* comprises demersal species that occupies soft substrate areas (YAÑEZ-ARANCIBIA; LARA-DOMINGUEZ, 1988), in which they feed by sand speculation. This behavior explains the dominance of benthic food items and the high frequency of sediment in the diet of *C. arenatus* in Maiandeua Island, and in the diet composition of other species from the genus in several estuaries in the Atlantic coast (DANTAS et al., 2013; DENADAI et al., 2013; REYES-RAMÍREZ et al., 2017). In addition, the benthivorous diet in *Cathorops* may be related to the morphology of the digestive tract and gustative papillae in the barbels (KOBELKOWSKY D.; CASTILLO-RIVERA, 1995; EIRAS-STOFELLA; FANK-DE-CARVALHO, 2002).

Marine catfishes prey on benthic crustaceans (TILNEY; HECHT, 1990; MENDOZA-CARRANZA, 2003; GIARRIZZO; SAINT-PAUL, 2008; KRUMME et al., 2008; MAZLAN et al., 2008; DENADAI et al., 2013; TAVARES; DI BENEDITTO, 2017),), hydrozoans (MUTO et al., 2014), polychaetes (DANTAS et al., 2013; MUTO et al., 2014), fish scales (SZELISTOWSKI, 1989; DENADAI et al., 2013), and mollusks (DENADAI et al.

et al., 2012; DANTAS et al., 2013). *C. arenatus* exhibits a consistent pattern of a benthivorous diet based on crustaceans in the Amazonian estuary. In addition, the predominant consumption of small prey (*e.g.* harparcticoids) is highlighted. In other studies, species of the genus *Cathorops* has fed on small prey when compared to other ariid genera, which may be favored by the lower number and size of gill rakers (KOBELKOWSKY D.; CASTILLO-RIVERA, 1995).

The North coast of Brazil exhibits major seasonal fluctuations in rainfall and salinity levels (PINHEIRO; FRÉDOU, 2004), which affect the abundance and distribution of both crustaceans and fish (BARLETTA et al., 2003; DIAS et al., 2009; MAGALHÃES et al., 2009; MOURÃO et al., 2015). Thus, seasonal variation in diet composition of fishes is a common pattern in estuarine fishes of the North coast of Brazil (GIARRIZZO; SAINT-PAUL, 2008; LOBATO et al., 2018). *C. arenatus* did not exhibit differences in its diet composition between rainy and dry seasons. In other estuaries, harpacticoid communities have shown species-specific fluctuations in abundance that led to a high stability in the total abundance of harpacticoids in these communities through time (CHERTOPRUD; AZOVSKY, 2006; GONÇALVES et al., 2010). If the same pattern holds in the estuaries of the North coast of Brazil, it would explain the dominance in the consumption of harpacticoids in both hydrological seasons by *C. arenatus* in Maiandeua Island.

Conclusion

Cathorops arenatus exhibits a benthivorous feeding habit in the Amazonian estuary. Evidences of temporal variation in its diet were not found, but further studies should use more temporarily comprehensive sampling and identification of prey in less inclusive taxa in order to address this question. We encourage a systematic review in the trophic niche of ariids. Many studies have addressed the feeding behavior and diet composition of ariids worldwide. A review of such literature will allow finding gaps in the knowledge of this family and answering general questions about the variation of the trophic niche in ariids.

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